A Summary of the Cassini Spacecraft Thermal Performance from Launch through Early Cruise

Arturo Avila, Nazilla Rouse, Stuart Clark, Glenn Tsuyuki, and Jerry Millard
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Mail Stop 125-121
Pasadena, California 91109

ABSTRACT

Cassini, NASA's mission to investigate the Saturnian system was launched successfully on October 15, 1997. The spacecraft (Orbiter and Titan Probe) is the largest and most sophisticated interplanetary vehicle ever launched. The cruise period from launch until Saturn arrival takes the spacecraft through a wide range of solar/thermal environments (0.67 astronomic units [AU] to 10 AU). The thermal control approach, which consists of thermal design features and operational constraints, must therefore maintain hardware temperature limits throughout this wide range of environments.

The spacecraft nominally points the HGA to the sun so that areas beneath the HGA are shaded while in the inner solar system (<5 AU). The Cassini mission design requires that the spacecraft be able to perform trajectory correction maneuvers with the HGA pointed away from the sun for limited duration's. The off-sun exposure flight experience with interplanetary spacecraft at relatively close heliocentric distance is very limited. Such off-sun maneuvers exposes the nominally shaded spacecraft components to direct solar irradiance. The ability to perform off-sun maneuvers relies heavily on the large thermal capacitance of the spacecraft's central body and the relatively short off-sun duration's required for these maneuvers. An integrated system level thermal balance test was performed prior to launch but off-sun attitude simulation was not feasible because of the size of the spacecraft and cost constraints. The post launch execution of the first trajectory correction maneuver was the first opportunity to validate the spacecraft off-sun capability.

This paper will present the spacecraft thermal performance from launch through early cruise. A comparison of flight data with predictions will be presented. Special attention will be focused on the in-flight off-sun maneuvers since ground testing for these maneuvers was not performed. In addition, operational changes resulting from in-flight lessons learned will be discussed. An outline of the proposed paper is attached.

A Summary of the Cassini Spacecraft Thermal Performance from Launch through Early Cruise

Outline

I. Introduction

A. Mission Description

B. Spacecraft Configuration
   1. Launch
   2. Cruise

II. Launch & Cruise Environments

A. Solar Distance Variation

B. Off-Sun Exposure Requirements at Close Sun Range

III. Thermal Control Description

A. Thermal Design Features

B. S/C Operational Constraints

C. System Level Fault Protection

IV. Flight Data and Prediction Comparison

A. Sun pointed (HGA to Sun) orientation

B. Off-Sun (Probe to Sun) orientation

C. Operational Changes Resulting from In-flight Lessons Learned

V. Conclusions